EXPERIMENTS WITH MODIFIED GRADE 2 BRAILLE CODES TO DETERMINE THEIR EFFECT ON READING SPEED

BY
J. LORIMER AND M.J. TOBIN

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EXPERIMENTS WITH MODIFIED GRADE 2 BRAILLE CODES TO DETERMINE THEIR EFFECT ON READING SPEED

John Lorimer and Michael J. Tobin

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The world-wide acceptance of braille as the principal reading medium for the blind is evidence of the versatility of the punctiform system invented by Louis Braille in the nineteenth century. There seem to be few languages that cannot accommodate themselves to it, and its victory over alternative systems has usually been easy. The only country where any sustained opposition was mounted is the United States where the opposition of adherents of the embossed Roman alphabet, Boston linetype, and New York Point has been documented, in all its acrimony, in Robert Irwin's "The War of the Dots" (Irwin, 1955). It has been claimed that, while effecting enormous space-saving as compared with embossed print, braille retains many of the advantages associated with conventional print displays. Foulke (1974) has listed these as ability of the reader: to vary his speed of reading; to 'retrace in order to process ambiguous material more thoroughly'; and to use lay-out features such as paragraph indenting, headings, and numbering as 'retrieval cues to guide' in the search for information. Another important point is that braille is both a reading and a writing system. Unlike its competitors, most of which can only be produced by craftsmen-controlled printing presses, braille can be written either by means of small, pocket-sized frames and styluses or under the control of the most advanced technology, with a wide range of intermediate devices available for special purposes. Despite these, and other, merits, users are only too well aware of the disadvantages they have to labour under as compared with their normally sighted peers. One of the most irksome is the relatively low reading speed attainable, even by the most experienced and proficient readers. In a survey of reading habits of blind people in the U.K., Gray and Todd (1967) found that in a silent reading test, only 85 out of 277 subjects (age range 16-65), read at a speed in excess of 100 w.p.m. and only seven of them reached over 200 w.p.m. In a study of the reading achievement of blind children, Williams (1971) found reading speed to increase steadily with age, but with a mean rate of 103 w.p.m. being attained only at age 16. Other investigations, including those of Meyers, Ethington, and Ashcroft (1958), Foulke, Amster, Nolan, and Bixler (1962), Nolan (1966), and Lorimer (1978), show a picture that is essentially the same, i.e. of braille readers reaching speeds massively inferior to those of their ink-print counterparts. Even the occasional discrepant result, such as that of Grunwald (1966), can be accounted for, as Nolan and Kederis (1969) put it, by "the atypical measure of reading" used in the research. Perhaps of greater significance than the relative slowness of braille reading (and probably of all tactual reading) is the fact that so many blind people fail to reach any useful level of proficiency. Williams (op.cit.) reported that of the 488 subjects (aged 10-16) in her study, 40% had to be excluded owing to failure to reach the basal criteria of 40 w.p.m. and a score of 9 on the comprehension test. Among a number of reasons put forward to explain failure to reach the pass criteria, Williams lists below-average intelligence and late admission to a school for the blind, both of which point up the complexity of the braille code and the need for early and prolonged teaching. Nolan and Kederis (op.cit.) also refer to "the greater complexity of the braille reading process as compared to print" and go on to infer from their investigation of the factors involved in braille word recognition that "the intellectual cut-off point for serious consideration of reading as an educational vehicle may be much higher for braille than for print".

The complexity of braille can be seen at two levels. Its six dot structure leads to a series of shapes that are, as Lorimer (1978) has put it, much "less uniquely distinctive" than the ink-print letters of the Roman alphabet and much more readily confusable with one another. Reversal and inversion errors are common, especially in the early stages of learning, as has been demonstrated by Lorimer (ibid) in his standardization of the Neale Analysis of Reading Ability test on blind school children. Superimposed on these perceptual problems are those stemming from the multiple meanings any single braille cell may have assigned to it. While the learner of our conventional ink-print orthography may have some difficulties with the letter-shape 'c' they are as nothing compared with those confronting the braille learner who has to determine whether the sign beneath his finger is to be decoded as c, can, com, con, cc, a colon, or a hyphen.

Perceptually and cognitively, therefore, braille makes great demands on the learner, whether he is a totally and congenitally blind child 'learning to read' or an adventitiously blinded adult learning not just to read - a complex skill he has already acquired - but learning to read by touch. Some of the research already cited above, and the spoken testimony of social workers and teachers working with adult subjects, suggest that it is a combination of these two factors that accounts for the failure of so many blind people to learn braille or use it with any proficiency. The tactual and perceptual problems are not susceptible to amelioration in any very straightforward manner, although pre-braille touch training, continued and systematic practice in character recognition during the course of braille learning, and the provision of materials in large and normal size cells might all serve to help and to motivate those learners whose problems are of this kind. The complexities of the code itself are, however, more amenable, probably without any significant consequential changes in terms of space-saving or of the basic structure of the code. Lochhead and Lorimer (1954), for example, have argued for 'some pruning of dead wood' and simplification of the rules of Standard English Grade 2 Braille. Other commentators also, such as Ashcroft (1960), Kederis, Siems, and Haynes (1965), and Nolan and Kederis (1969), have drawn attention to the low frequency of occurrence of certain contractions and the learning and other problems associated with multiple meanings. Douce and Tobin (1976) have argued that the time is now ripe for taking up some of these points and subjecting them to empirical investigation with the ultimate aim of making braille accessible to a much larger proportion of the blind population.

As a direct result of the discussion paper circulated by Douce and Tobin, the Department of Health and Social Security agreed to fund a joint investigation by Birmingham and Warwick Universities into ways of extending the use of braille and of improving braille reading skills. Such a multi-faceted project needs to be set in a framework of criteria and limitations that will suggest attainable goals. Braille is not only a means of communication; for many people it has personal and emotional connotations related to its function as their mode of access to independence, work, and their cultural heritage. Changes to it can appear to be threatening and disruptive. For these reasons, therefore, proposals regarding possible changes should be seen to stem from rational and empirical evidence that can be studied and evaluated by the users. The studies reported below should be seen as part of an attempt to gather such evidence. They were conceived within the framework of four major criteria, viz. retention of the existing seven-line structure, the saving of space, maintenance at least of current standards of fluency and speed, and reduction in learning load.

Purpose

The following series of experiments were undertaken during the first year of the joint project as part of the preliminary, 'ground-clearing' exercise to determine the effects on braille reading speeds of various kinds of code modifications. At the same time, other investigations were being set up, such as the computer-controlled analysis of letter-combination and word frequencies

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at Warwick and the empirical evaluation of various 'rapid-reading' techniques with adolescents attending schools for the blind (all of which will be reported in due course). Code modifications fall into two categories: code reduction and code extension. Both can have effects on the size of braille publications, and these effects can be calculated easily and accurately. Such modifications will also have implications for the teaching and learning of braille. Here, again, it is possible to make some assessment in advance of the changes. Reductions of the code will generally decrease the number of rules - and exceptions - that have to be taught and so make the learner's task easier. Code extensions will normally increase the learning load. Experimental investigation is neither necessary nor appropriate in relation to these two sets of effects. Their effects upon reading speeds are not readily forseeable, however, and yet it is clearly important that any recommendations for code changes should be made on the basis of as complete an understanding of their consequences as it is feasible to achieve. The studies now reported should be seen as part of an attempt to fill the information gap and so make it easier for the braille-reading community to make the decisions that are their prerogative.

Subjects

The first three experiments were carried out on premises in Harborne, Birmingham, belonging to the Birmingham Royal Institution for the Blind, and the subjects were obtained with the help of officers of the Institution (this group will henceforth be designated as the 'Harborne group'). A total of 16 volunteers participated, 12 men and 4 women, aged between 24 and 69 years (mean, 49.5 years), their occupations being those of:- lawyer, telephonist, school-teacher, assemblers and packers in factories, office-workers, piano-tuner, physiotherapists, computer programmer, warden of hostel, machine operator, and welfare superintendent. All were registered as blind, read by touch only, and had used braille for more than five years (most having learned it at school and having been braille readers all their lives), and were regular users of braille for work and recreation.

Two further replications of the third experiment were carried out with two other groups. The first group consisted of nine adult volunteers (3 men, 6 women) who were either retired, not in regular employment, or were housewives. They were aged 40 years and upwards, registered as blind, and most admitted to not using braille on a regular, daily basis. The second group comprised 16 adolescent pupils at a school for the blind (8 boys, 8 girls) aged 14-17 years, and all were regular daily users of braille.

In the fourth experiment, 12 of the Harborne group participated (8 men and 4 women).

Design, Methods, and Procedure

In each experiment, a repeated measures, counterbalancing design was used. That is, each subject read two passages of prose, one in Standard English Braille, Grade 2, and the other in a modified code. To overcome some of the effects of order of presentation and possible differences in difficulty, interest, and style of the selected passages, each was brailled in the two codes, and subjects were then randomly assigned to one of four groups. In this way, each passage and each braille code appeared in first and second place an approximately equal number of times, thus making it possible to use a straightforward statistical test of the significance of the difference between correlated means, the means being those for rate of reading in the standard and the modified codes.

The subjects read the passages silently and then, in Experiments 3 and 4, answered five multiple-choice questions designed to ensure they had read the passages with reasonable levels of comprehension. The prose selections can best be described as being non-fiction of a content and level of difficulty appropriate to senior school pupils of average ability (they were drawn from the last two books of "New Reading", a series of graduated readers prepared for such students). In Experiment 2, however, the passages were taken from "Reader's Digest". No attempt was made to edit the texts in order to change the incidence of contractions. Full details of the modified codes are given in the Appendix but may be summarized as follows:-

Experiment 1. A reduced code of 57 contractions, containing mainly single-cell upper-word and part-word signs. The effect of not using over two-thirds of the standard code was to increase Grade 2 space by 6%. The proportion of available signs used was higher in the modified versions (75%) than in the Grade 2 versions (50%). Subjects were not given any prior 'sight' of the modified code.

Experiment 2. A reduced code containing the first 60 signs listed in order of space-saving value in a count of the frequency of occurrence of contractions in non-fiction texts recently completed at Warwick University. The 13 alphabet word-signs not appearing among these 60 signs were included to give a total of 73 contractions. The omission of the remaining contractions increased Grade 2 space by about 4.5% and affected one in eight of the words used in the passages. Approximately 55% of Grade 2 signs and 75% of the available signs in the modified code actually appeared in the passages. Subjects were provided with details of the modifications in advance and an opportunity to practise reading a list of words containing the modifications.

Experiment 3. A reduced code of 81 contractions, selected on the basis of space-saving efficiency from the Lochhead and Lorimer (1954) and Warwick University counts, the aim being a list of signs doing 90% of the space-saving achieved by all the contractions of Standard English Grade 2. In the modified versions of the two prose passages, total Grade 2 space (including punctuation and inter-word spaces) increased by just over 2%, and about one in every 22 words was affected by the omission of contractions. Approximately 65% of the available signs in the reduced code were actually used as against 37% of the full code. Subjects were provided with details of the modifications in advance and an opportunity to practise reading a list of words containing the modifications.

Experiment 4. An extended code consisting of the existing Grade 2 signs together with 37 new signs formed by outlining words and by using some of the one and two-space signs not at present employed as word-signs. Contractions were assigned to words shown in the Warwick University count to have the highest space-saving potential. A new sign occurred about once in every eleven words of the test passages and the 37 signs together reduced Grade 2 space by nearly 3.5%. No changes in Grade 2 meanings or rules were made. Subjects were provided with details of the modifications in advance and an opportunity to practise reading a list of words containing the modifications.

Results

Summary statistics and the results of analyses are shown in Table 1. As our initial questions are as to whether there are any differences between the alternative codes in relation to speed of reading, a two-tailed t-test has been applied in each case. In Experiment 1, it would seem that reducing the number of contractions and not allowing the subjects to have any pre-practice with the reduced code have brought about differences in reading rate, with the Standard Braille texts being read more rapidly. Examination of the individual rates showed that 13 out of the 15 readers were faster with Standard Braille. In Experiments 2 and 3, and the two replications of Experiment 3, null hypotheses

of no statistically significant differences in reading rates as between the alternative codes could not be rejected. The massive reductions in the number of contractions did not appear to influence mean reading speeds in any substantial way. Nine of the 16 subjects in Experiment 2 read the reduced code more rapidly, while of the 39 subjects participating in Experiment 3 and its replications, 14 were faster on the modified code and 25 faster on the Standard Braille. Comprehension, as measured by the simple, five multiple choice questions for each passage, was at the 80% level in each case. In Experiment 4, expansion of the code, even with prior practice with the new signs in their own homes, led to problems for the readers, as evidenced by the significantly superior mean rate on the Standard Braille test. Only one of the 12 subjects read the expanded braille code passage more rapidly than the Standard Braille.

Discussion

For practical purposes, the number of ways in which the code can be changed is relatively small, if the four general criteria and restrictions already posited are accepted. These are the retention of the existing, basic seven-line structure; no increase in bulk of braille publications; maintenance, at least, of current fluency and speed of reading; and an easing in the learning load, for new, especially newly-blinded adult, learners. Our preliminary investigations have shown that apparently massive changes can be made without any distortion of the structure of braille. This is largely due to the fact that the reduced codes of Experiment 2 and 3 retained the core of the present system, with the deletions being confined to those signs that occur relatively infrequently and that are essentially extensions and combinations of the shapes and meanings of the original elements of the seven-line system. The codes used in these two experiments also met the requirements of the third and fourth criteria. No reduction in reading speed was discernible and the diminution in the number of rules to be learned would clearly lead to an easing of the learning load. Whether the increases in space demanded by the two codes are of any significance is open to question. Some of the increase would be 'lost' by the filling of unused spaces at ends of lines, paragraphs, and chapters; and there can be little doubt that further analyses would suggest means of reducing the space requirements of a reduced code.

The fourth experiment indicated that some expanded codes can meet the second criterion of space-saving - and again not materially alter the existing structure. However, it seems that there is a limit to the amount of saving that can be effected. For example, to bring about a 10% reduction in bulk would require that an average of 400 to 450 spaces per 1,000 running words be saved. This, in turn, would probably entail the addition of over 100 new contractions and so infringe the criteria of reduction in learning load and no distortion of the existing structure. Less ambitious savings would be compatible with the latter requirement but if they were associated with new contractions it is difficult to see how they would conform with the learning criterion, unless of course they were counter-balanced by 'pruning' elsewhere.

Our ground-clearing exercise is by no means completed and it is hoped that further analyses at Warwick of letter and word frequency will help to set the parameters within which new experiments can be designed and so result in the amassing of a body of information that can be set alongside evidence of other kinds when decisions about code changes are under consideration.

TABLE 1. COMPARISONS OF MEAN READING SPEEDS IN STANDARD AND MODIFIED CODES

	Number of Subjects	Length of Passages	Mean Reading Speed and Standard Deviation		t	Probability
			Standard Braille	Modified Braille		
EXPERIMENT 1	15	900 words	94 w.p.m. S.D. 47.94	77 w.p.m. S.D. 38.50	4.448	Significant at 1% level
EXPERIMENT 2	16	1275 words	91 w.p.m. S.D. 38.06	95 w.p.m. S.D. 44.85	1.062	Not statistically significant
EXPERIMENT 3	14	490 words	76 w.p.m. S.D. 29.63	78 w.p.m. S.D. 28.06	0.579	Not statistically significant
1st Replication	9	490 words	53 w.p.m. S.D. 16.90	50 w.p.m. S.D. 23.92	0.773	Not statistically significant
2nd Replication	16	490 words	70 w.p.m. S.D. 23.88	64 w.p.m. S.D. 22.25	1.325	Not statistically significant
EXPERIMENT 4	12	760 words	107 w.p.m. S.D. 33.80	94 w.p.m. S.D. 29.32	3.571	Significant at 1% level

APPENDIX

1. Content of modified code used in first experiment:

All alphabet words

AND FOR OF THE WITH

CH GH SH TH WH ED ER OW ST AR ING BLE OU

EN IN (as parts of words only)

TO INTO BY

WAS WERE

AGAIN AFTER ABOUT ALWAYS COULD GOOD WOULD SAID HIM

These 57 signs between them perform 74% of the space saving achieved by the whole of Grade 2.

2. The modified code used in the second experiment contained 73 contractions and was derived from "An Analysis of Braille Contractions" (Gill and Humphreys, May, 1977).

The contractions used were:

THE AND ING ER IN TO OF EN ED ATION ST FOR AR THAT WITH

EA CH TION CON MENT OU WHICH COM THIS FROM TH BLE BY OW SH

BE HAVE WILL SHOULD WAS YOU NOT PART THERE SION WORK WH DIS

ANCE BLIND SHALL THEIR WOULD ENCE PEOPLE IT AS ALLY WERE UNDER

CHILDREN TIME HIS THESE ONE CAN DO EVERY GO JUST KNOWLEDGE

LIKE MORE QUITE RATHER SO US VERY

3. Content of modified contracted code used in third experiment:

31 single-cell word signs:

and, for, of, the, with, out, this, which, and all alphabet word signs (but, can, do, every, etc.).

14 two-space signs used as words or parts of words:

ever, had, one, some, there, their, time, about, after, could, him, little, said, would.

8 lower signs used as words:

be, by, his, in, into, to, was, were.

23 upper signs used only as parts of words:

ar, ble, ch, ed, er, gh, ing, ou, ow, sh, st, th, wh, ally, ance, ation, ence, ment, ness, ong, ound, sion, tion.

5 lower signs used only as parts of words:

com, con, dis, ea, en.

4. Additional contractions used in the fourth experiment (37 new meanings):

9 word signs which were used as words only:

KN = KNEW
MN = MAN
4,5N = NEXT
3,4,6 = ON
letter O = ONLY
SW = SAW
TH sign N = THAN
4,5,6U = UNTIL
WL = WELL

28 word signs which were also used as parts of words:

5B = BACK
CM = CAME
DD = DID
FW = FEW
4,5,6F = FOLLOW
GV = GAVE
HS = HAS
1,2,4,6 = HE
GH sign = IS
KP = KEEP
KPT = KEPT
LK = LOOK
MD = MADE
MK = MAKE
MKG = MAKING
4,5M = MIGHT
NW = NEW
4,5,O = OTHER
4,5,6O = OVER
4,5P = POSSIBLE
4,5,6P = PLACE
4,5S = SEEM
SN = SOON
TK = TOOK
4,5T = TURN
ST sign D = STOOD
WH sign T = WHAT
4,5,6WH = WHILE

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